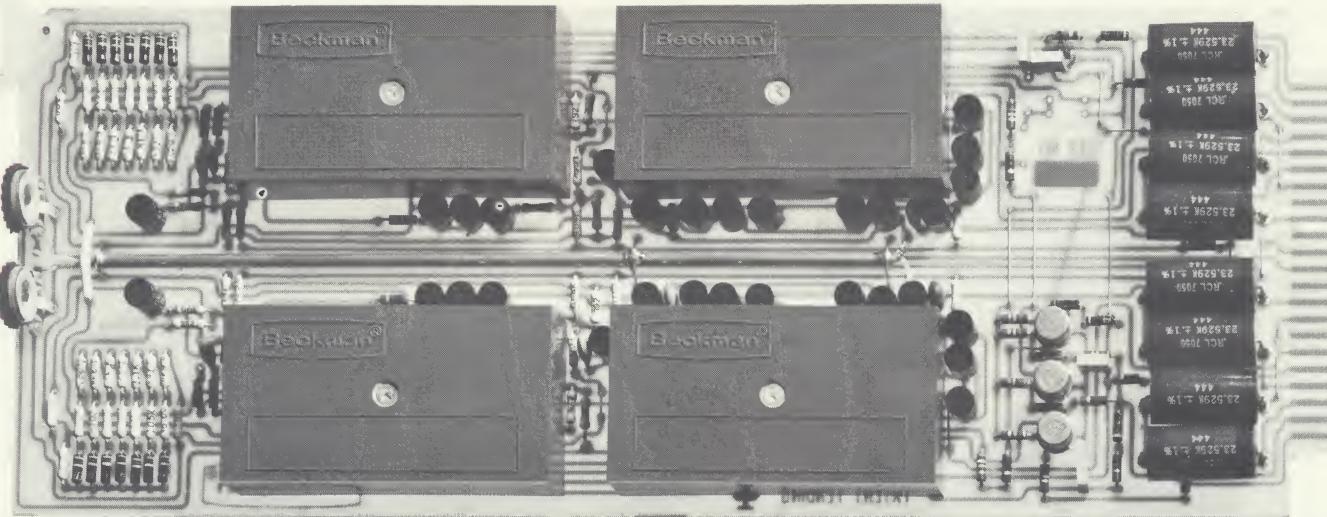


# data bulletin

Beckman

COMPUTER OPERATIONS

TYPE 30.20

QUARTER SQUARE  
MULTIPLIER

## UNEXCELLED STATIC AND DYNAMIC OPERATION

Beckman again sets a precedent in analog computing technology with its new Quarter Square Multiplier — providing unexcelled static and dynamic accuracies, without sacrificing bandwidth or stability. This all solid-state, highly reliable Type 30.20 multiplier provides you with a computational bandwidth in excess of 1000 cps and a frequency response in excess of 30 kc. These features allow non-linear algebraic and differential equations as well as iterative routines to be solved over a frequency range previously reserved for linear devices. For the first time, rapidly changing variables can be computed at high speed and high accuracy.

Designed primarily for Beckman 2200 Series EASE® Analog Computers and Beckman/SDS Integrated Computing Systems, the Type 30.20 multiplier is used with two operational amplifiers. The multiplier can accept any

combination of two inputs (X,Y)—both of which may vary  $\pm 100$  volts. Through transference control at the computer's Program Control Board, these outputs provide scaled products, quotients, squares, or square roots—at static accuracies previously reserved for time division multipliers. Every other channel is capable of division and every fourth channel can be used for square root calculation. No analog patchboard changes are required to program these transferences.

The advanced, all solid-state design of the Type 30.20 multiplier also provides unexcelled stability—without requiring a temperature stabilized oven. As an example of this stability, the Type 30.20 multiplier normally does not require more than two adjustments over a one-year period. When required, however, adjustments are accommodated by only two easily accessible controls.

## QUARTER SQUARE MULTIPLIER SPECIFICATIONS

### MULTIPLY TRANSFERENCE MODE

#### STATIC CONDITIONS

##### Input

Type: Two independent voltages  $X$  and  $Y$ .

Range: Both inputs can vary  $\pm 100$  v,  
 $|X+Y| \div 2 \leq 100$  v.

##### Output

Type: Voltage equal to  $XY \div 100$ .

Range:  $\pm 100$  v.

Error (max): 2 mv for  $X=0, Y=0$ .

15 mv for  $-100 \leq X \leq 100, Y=0$ .

15 mv for  $X=0, -100 \leq Y \leq 100$ .

25 mv for  $-100 \leq X \leq 100, -100 \leq Y \leq 100$ .

Temperature Effect: 2 mv/°F.

Noise (max): 15 mv p-p wide band.

### DYNAMIC CONDITIONS

##### Output

Error (max)  $-100 \leq X \leq 100, Y=200$  v p-p:

100 mv peak at 100 cps.

1 v peak at 1000 cps.

Frequency Response (-3-db point): 40 kc when  $X=100$  v,  
 $Y=50 \sin \omega t$  (less than 0.1-db peaking).

### DIVIDE TRANSFERENCE MODE

#### STATIC CONDITIONS

##### Input

Type: Two independent voltages  $X$  and  $Y$ .

Range:  $-100 \leq X \leq 100, -100 \leq Y \leq 0, |X+Y| \leq 1$ .

##### Output

Type: Bipolar voltage equal to  $100 (X \div Y)$  and  $-100 (X \div Y)$ .

Range:  $\pm 100$  v (dependent upon  $X$ ).

Error: Dependent upon  $Y$ . For  $Y=-100$  v and  
 $-100 \leq X \leq 100$ , less than 25 mv.

In general,  $\epsilon \leq 25$  mv ( $100 \div |Y|$ ).

### SQUARE ROOT TRANSFERENCE MODE

#### STATIC CONDITIONS

##### Input

Type: Voltage  $X$ .

Range:  $\pm 100$  v.

##### Output

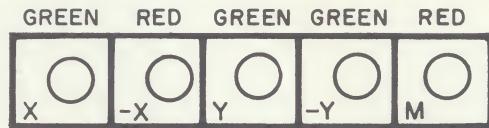
Type: Bipolar voltage equal to  $-10(|X| \div X \sqrt{|X|})$  and  
 $10(|X| \div \sqrt{|X|})$ .

Range:  $\pm 100$  v.

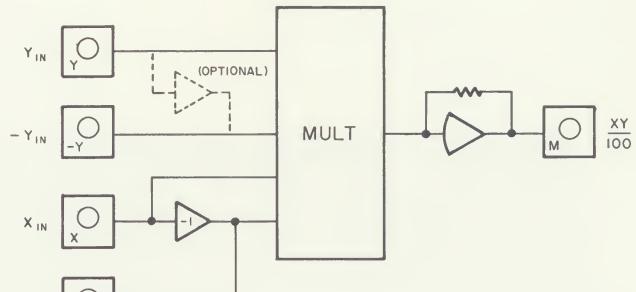
Error:  $X=100$  v,  $\epsilon \leq 25$  mv.

In general,  $\epsilon \leq 0.02 \div \sqrt{|X|} + 0.023$ .

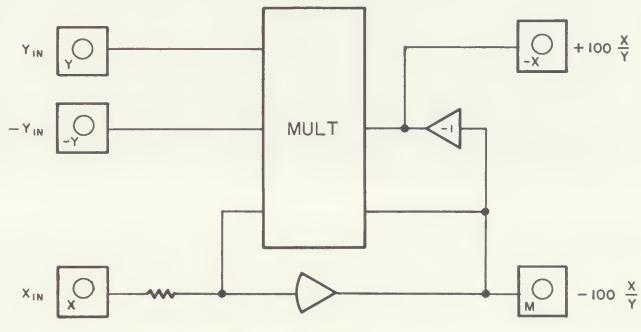
Due to a continuing program to incorporate the latest technical advancements into all Beckman products, specifications are subject to change without notice.



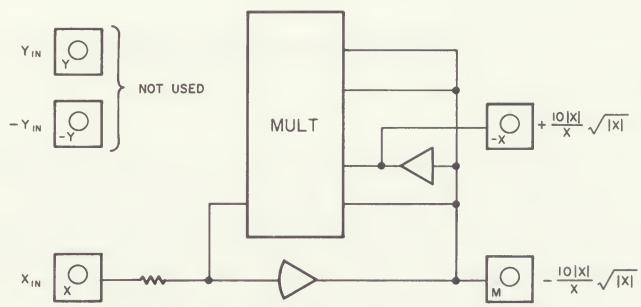
Multiplier Portion of  
Analog Patchboard



Multiply Transference



Divide Transference



Square Root Transference

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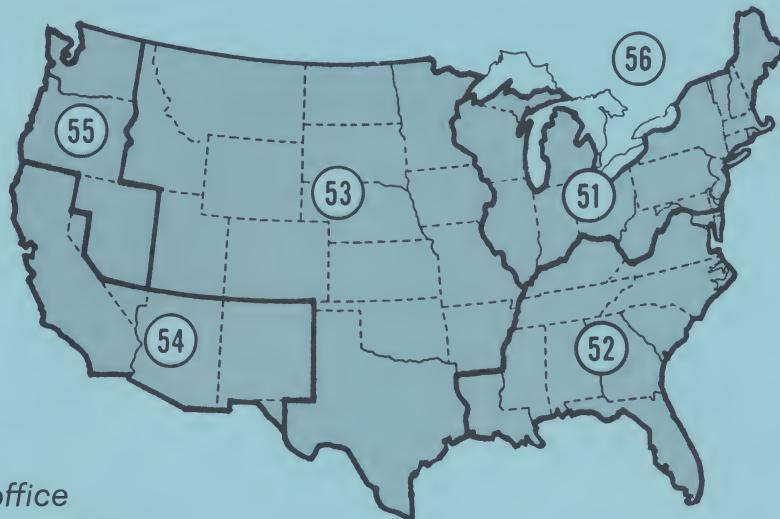
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